TITANOTHERES FROM THE TITUS CANYON FORMATION, CALIFORNIA

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Introduction.—The Titus Canyon formation of Oligocene age, occurring in the Death Valley region of California, was described in a recent paper by Stock and Bode.[1] Brief mention was made at that time of the fossil mammals found in this formation. Among these, the titanotheres were the first to be discovered and moreover are known by the best preserved material. These types possess special interest because of their relationships. They likewise record for the first time the presence of titanotheres in the lower Tertiary of the Great Basin Province. It should be recalled in this connection that titanotheres have been described recently from the Sespe uppermost Eocene of southern California.[2]

Protitanops curryi, n. gen. and n. sp.

Type Specimen.—Skull and jaws, No. 1854, C. I. T. Coll. Vert. Pale., Plate 1, figures 1–3.

Locality.—No. 253, C. I. T. Vert. Pale. Loc., lower red beds of Titus Canyon formation in canyon east of Thimble Peak, Grapevine Mountains, California.

Generic and Specific Characters.—Upper incisors 2; teeth small, crowns oval and non-cingulate. Canines less robust than in *Brontops*. Small diastema between canine and $P\frac{1}{1}$. Premolars with well developed internal cingula, but no external cingula. Nasals long and broad. Horns larger than in *Protitanotherium*, oval in cross-section, but with transverse diameter greater in relation to fore and aft diameter than in Uinta genus. Horns directed outward as well as upward. Dorsal surface of cranium narrow. Size large and intermediate between that of *Protitanotherium emarginatum* and that of *Brontops robustus*. This species is named for H. Donald Curry, discoverer of the first titanothere in the lower Tertiary of the Grapevine Mountains.

Description.—The zygomacephalic index is 71.4 and places *Protitanops curryi* within the brachycephalic division of titanotheres, according to the grouping of skull indices adopted by Osborn.[3] The skull, No. 1854, represents a larger and heavier animal than any so far recorded from Eocene horizons in North America. *Protitanotherium* and *Eotitanotherium* come nearest in size among the late Eocene types. Considerably smaller are the species *Teleodus uintensis* from the Duchesne River horizon and *T. californicus* from the Sespe.

The nasals in specimen No. 1854 are not so long nor so broad as in *Protitanotherium*. They do not taper anteriorly but their antero-internal termination is sharper than in the latter genus. When viewed from the side (Plate 1, figure 1) the naso-maxillary notch is seen to be narrow dorsoventrally and more deeply incised than in typical members of the lower Oligocene group of titanotheres. The lower border of the notch extends well forward, even though the incisor teeth show reduction in number and considerable reduction in size. More is preserved of the left horn than of the right. The dorsal and external surfaces are rugose and the latter shows at least one large abrasion which may indicate that the surface suffered some damage during the life of the individual. Due to some distortion of the skull the left horn extends not only upward but also to the outer side. However, its lateral direction does not appear to be wholly accounted for on this basis and the normal attitude may have involved projection outward as well as upward. When viewed from the top the principal axes of the horns are seen to be slightly divergent toward the anterior end of the skull. This oblique direction of the axis is more markedly displayed in the left horn than in the right.

The zygomatic arches are widely spread and the dorso-external surface of the zygomatic process of the squamosal possesses considerable breadth. On the other hand, the flattened parietal roof of the cranium is quite narrow. In this regard *P. curryi* exhibits apparently a primitive character and certainly differs from the White River types of titanotheres. The lateral cranial surface slopes away from the edge of the dorsal surface in No. 1854, whereas in the later American titanotheres there is definite tendency on the part of the lateral surface to undercut the dorsal plane. The flatness of the parietal plane is continued forward on the frontals and the dorsal profile exhibits no convexity as in the Brontotheriinae. The sides of the frontals above the orbits, as seen from above (Plate 1, figure 2), are parallel.

The post-tympanic process of the squamosal forms a broad plate transversely and encroaches closely upon the surface of the postglenoid process leaving only a narrow space below the external auditory meatus. The occiput is likewise broad transversely and possesses a large and deep median concavity. A small V-shaped notch incises the occipital crest on the middle line.

The upper incisors are small teeth in relation to the size of the skull. Their number is reduced to two on either side of the median line. Unfortunately the lower incisors are not preserved. In size and in presence of smooth oval crowns these teeth emphasize the wide difference between *Protitanops curryi* and the upper Eocene genera of titanotheres and exhibit the progressive characters seen in lower Oligocene forms. The crown of the canine is likewise relatively small and is not swollen. A short space prevails between the canine and the first premolar. No distinct tetartocone


1
2
3

is present in $P\underline{2}$; the deuterocone and tetartocone are represented by a ridge which extends along the inner side of the crown and shows no separation into two cusps. In $P\underline{3}$ the worn surface of the tetartocone is circular in outline and the cusp, while prominent, is still distinctly smaller than the deuterocone. This discrepancy in size between the two cusps is more noticeable in $P\underline{4}$, where the size of the tetartocone is decidedly smaller than that in $P\underline{3}$. Well developed internal cingula are present in the premolars but external cingula are absent. The molars are considerably worn, but show no evidence of the presence of cingula.

The inner border of the upper cheek-tooth series is practically straight and the premolars are not curvilinear as in *Brontotherium*. As seen from the side, however, the series has a curvature with an upward flexure of the premolars.

In the lower jaw the angle extends below the level of the inferior border of the ramus but does not extend very noticeably beyond the level of the condyle. The anterior end of the jaw is not preserved.

Remarks.—Protitanops curryi is certainly more advanced than any of the titanotheres thus far recorded from the American upper Eocene. In comparison to *Protitanotherium* and *Eotitanotherium* the Titus Canyon form possesses better developed horns and considerably more reduced incisors. *P. curryi* is likewise a larger and more advanced form than the titanotheres (*Teleodus uintensis* and *T. californicus*) recorded from the basal Oligocene Duchesne River beds or the uppermost Eocene Sespe. In its large size, brachycephaly, strong zygomata and reduced character of upper incisors, *P. curryi* is more like the lower Oligocene titanotheres of the White River beds. It is, however, distinct from any known White River titanothere in the combination of characters which it possesses, namely, long and broad nasals, narrow and deeply incised naso-maxillary notch, type of horn and narrow dorsal plane of skull.

Resemblance to the brontotheriine titanotheres is shown in the transversely broad occiput, close approach of the posttympanic process to the postglenoid process, wide spread of the zygomatic arches, upward flexure of premolar teeth, presence of tetartocones in posterior premolars and possibly in shape of angle of lower jaw. On the other hand, it differs from *Brontotherium* in the small size of the incisors, absence of cingulate crowns in these teeth, small and non-swollen type of crown in canine, attitude and cross-section of horn and in absence of convexity in profile of the parieto-frontal surface.

PLATE 1

Protitanops curryi, n. gen. and n. sp.

Figures 1, 2, 3. Type specimen, skull, No. 1854, Calif. Inst. Tech. Coll. Vert. Pale. Lateral, dorsal and ventral views; × 1/6. Oblique lines show restored areas.

Titus Canyon Formation, California. Lower Oligocene.

Resemblance to the brontopine titanotheres is indicated in the number, size and type of crown of the incisors, small canine, shape of horn and in the concave profile of the dorsal surface of the skull.

Relationship of the Titus Canyon titanothere is apparently closer to the White River forms than to known upper Eocene types. However, in comparison with the former *Protitanops curryi* is more primitive and suggests in this regard an earlier stage of the Oligocene than that recorded in the White River deposits.

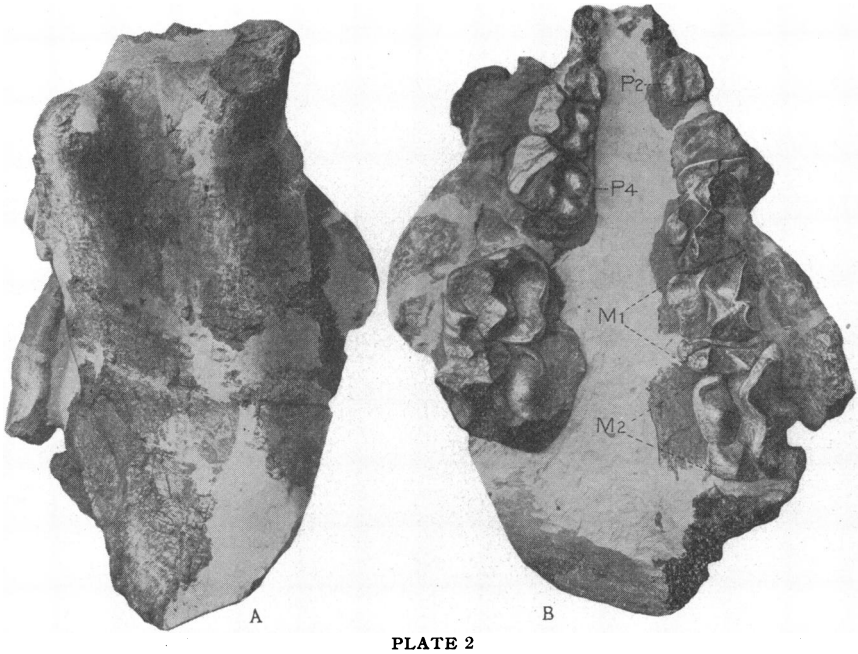

PLATE 2

Menodontine (?) titanothere

Figures A, B. Fragmentary skull, No. 2007, Calif. Inst. Tech. Coll. Vert. Pale. Dorsal and ventral views; approx. × 1/6.

Titus Canyon Formation, California. Lower Oligocene.

MEASUREMENTS (IN MILLIMETERS) OF NO. 1854

Length from tip of nasals to occipital condyles	697
Length from tip of nasals to occipital crest	690
Length from anterior end of premaxillaries to posterior end of condyles	680
Length from anterior end of premaxillary to posterior side of postglenoid process (approximate)	568
Length from anterior end of premaxillaries to postnarial notch	290
Greatest width across zygomatic arches	486
Least width between orbits (approximate)	195
Width of nasals	120

Width of muzzle	82
Least width of parietal roof	82
Greatest width of zygomatic process of squamosal	96
Width across occipital crest	264
Width across condyles	146
Length of horn	103
Width of horn	64
Length from anterior end of canine to posterior end of M^3	330.4
Length of cheek-tooth series of P_1–M_3 (approximate)	272
Distance from top of coronoid process to inferior border of ramus	297
Distance from condyle to inferior border of ramus	277
Depth of ramus at posterior end of M_3	137
Depth of ramus at anterior end of M_1 (approximate)	108

Menodontine? Titanothere.—A poorly preserved facial portion of a skull, No. 2007, C. I. T., Coll. from locality 255, represents a titanothere which is apparently distinct from *Protitanops curryi*. This specimen occurred in the lower red beds of the Titus Canyon formation exposed in the west fork of Titus Canyon, Grapevine Mts., California. Its stratigraphic position is therefore similar to that of *Protitanops curryi*.

This specimen (Plate 2) is smaller than the type of *P. curryi*. At least one molar crown is fairly well preserved. The transverse diameter of the crown, in relation to the anteroposterior diameter, is less in this tooth than in the comparable tooth of *Protitanops*. A faint external cingulum can be discerned on the molars. The premolars (P_2–P_4) are distinctly larger than the comparable teeth in *Protitanops*. As in the latter, the teeth possess strong internal cingula, but they likewise have very faint external cingula. In P_2 a low crest marks the position of the deuterocone and tetartocone. The two inner cusps are distinct in P_3 and P_4. In these teeth the deuterocone is situated well back of the anterior border of the tooth, leaving a distinct shelf in front. The external surfaces of the two outer cusps in P_2 and P_3 are convex and ribbed.

Little is left of the horns, but they appear to possess a round or rudely triangular cross-section.

Relationship of No. 2007 to the menodontine titanotheres among the White River Brontotheriidae is suggested particularly by the elongate molars and to some extent also by the basal cross-section of the horn.

[1] Stock, C., and Bode, F. D., *Proc. Nat. Acad. Sci.*, **21**, 571–579 (1935).

[2] Stock, C., *Proc. Nat. Acad. Sci.*, **21**, 456–462 (1935).

[3] Osborn, H. F., *U. S. Geol. Surv. Mon.* **55**, 1, 259(1930).